NASA/TM–2003–206892, Vol. 26

SeaWiFS Postlaunch Technical Report Series

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Volume 26, New Laboratory Methods for Characterizing the Immersion Factors of Irradiance Sensors

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July 2003

Chapter 1

Overview and the Traditional Method

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Abstract

Whether for a single aperture or multi-aperture sensor, the traditional method for characterizing the immersion factor of an in-water irradiance sensor involves a relatively simple procedure and can be recounted as a small number of steps: a) a tungsten-halogen lamp, with a small filament and powered by a stable power supply, is placed at some distance above the diffuser(s); b) the instrument is placed in a tank of water with the irradiance diffuser(s) level and facing upward; c) the depth of the water is lowered in (5 cm) increments and readings are recorded for all wavelengths from each carefully measured depth; d) a final reading is taken with the water level below the collector(s) with the diffuser(s) dry. Computing the immersion factor from the recordings requires a correction to the irradiance values at each depth interval to account for the change in solid angle of the light leaving the source and arriving at the diffuser(s), which is caused by the light rays geometrically changing direction at the air–water interface.

1.1 INTRODUCTION

SIRREX-8 was conducted using Satlantic, Inc. (Halifax, Canada) ocean color irradiance series-200 (OCI-200) sensors. To eliminate any chance of bias associated with one group's implementation of the immersion factor measurement protocol, three different facilities participated in the SIRREX-8 activity, and a common set of nine sensors were characterized at each facility. The three groups that participated were CHORS, JRC, and Satlantic, Inc. Although there were differences between the methods used at each facility, the basic protocol was the same and in keeping with the traditional method (Petzold and Austin 1988).

The primary objective of SIRREX-8 was a detailed investigation of the immersion factor: a) quantify the uncertainties associated with measuring the immersion factor with a standard protocol, b) establish if instrument-to-instrument variability prevents the assignment of a set of immersion factors for an entire series of sensors, and c) compare average immersion factors obtained from sample OCI-200 radiometers with those provided by the manufacturer for the same series of instruments. A secondary objective was to measure the cosine response of one sensor at two of the facilities, and a tertiary objective was to explore new laboratory methods and equipment for characterizing in-water irradiance sensors. These latter inquiries took place at CHORS and the JRC.

Both downward and upward irradiance sensors, $E_d(\lambda)$ and $E_u(\lambda)$, respectively, were measured during SIRREX-8. The reason for selecting both sensor types was an $E_u(\lambda)$ sensor is more sensitive, so its signal-to-noise ratio (SNR) is higher. The distinction was considered important, because some of the lamps frequently used in optical experiments have a low flux in the blue part of the spectrum. The greater sensitivity of E_u sensors means lower wattage lamps and greater lamp-to-sensor distances can be used without degrading the data. The use of lower wattage lamps is an experimental advantage, because they have smaller filaments, so the approximation that the lamp is a point source is better satisfied. The use of greater lamp-to-sensor distances (keeping the same sized filament) significantly improves the point-source approximation and permits different experimental distances at satisfactory flux (or SNR) levels.

Satlantic OCI-200 sensors were selected for SIRREX-8, because they are compact (so they can be accommodated in relatively small water vessels) and are widely used by the broader ocean color community (so any conclusions derived from their use would have a larger applicability).